Technology Opportunity

Structural Benchmark Test Facility Aids Computer Industry

The Structures Division of the National Aeronautics and Space Administration (NASA) Lewis Research Center seeks to aid in evaluating materials and structures for advanced engineering applications (such as biomedical devices (prosthetics), structural integrity, design and manufacturing, composite materials, metals, plastics, and ceramics). Benefits include low-cost material evaluations under prototypical operating conditions (high temperatures, multiaxial loads, environmental durability, etc.), reduced part rejection rates, improved structural durability, and improved material processing methods.

Potential Commercial Uses

- Verify structural analysis methods under prototypical loading conditions
- Aid in the investigation and characterization of the multiaxial behavior of common materials

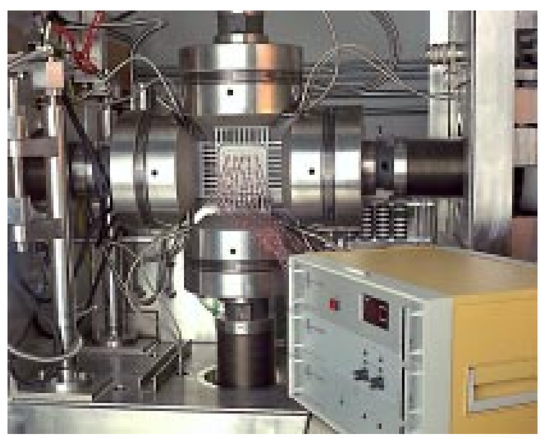
Benefits

- Structural integrity of advanced monolithic and composite materials can be evaluated in subelement form.
- Specimens can be mechanically loaded and uniformly heated in a highly controlled and precise manner.
- Analysis is less complicated.

Biaxial yield and failure information for stainless steel sheet material is being used to improve recording head suspension assemblies for the computer industry. This information could not have existed without Lewis' in-plane biaxial test systems. Hutchinson Technology is using these data to design new suspension elements, such as stiffer rails and uniform gimballing pivots. These design improvements, along with new forming processes, will increase suspension performance—ultimately providing the computer industry with an inexpensive means of increasing disk storage capacity and disk access rates.

The Technology

Recording head suspension assemblies for computer disk drives greatly influence disk data storage capacity, data access rates, and drive and data reliability. These very precise metal springs hold the recording heads at microscopic distances above the magnetic disks. Improvements to the disk drive performance are directly related to the suspension assemblies. For instance, reducing the suspension weight can increase the data access rate. Likewise, fabricating the suspension assemblies with the appropriate compliance can improve the accuracy of the recording head position. This, in turn, increases the aerial density (disk storage capacity) of the magnetic disk and improves reliability. These design details dictate the use of very thin metals with well characterized physical properties. Unfortunately, information about these thin metals is very



NASA Lewis' Structural Benchmark Test Facility.

limited, and applying this limited information to a complicated design/manufacturing problem requires extensive interpretation of existing data. That is why Hutchinson Technology of Minnesota, developer and manufacturer of 70 percent of the world's recording head suspension assemblies for the computer industry, asked St. Cloud State University and NASA Lewis to investigate the multiaxial behavior of the thin sheet stainless steel that they use in designing and manufacturing these suspension assemblies.

The thin metals used for these assemblies are typically processed to their final thickness via cold (or warm) rolling. Cold working of a metal changes its microstructure and associated properties. In fact, the grains take on a preferred orientation (or texturing) that aligns the crystal structure differently in the rolling direction than in the transverse direction—transforming the material from one with similar properties in all directions (isotropic) to one with substantial property differences with respect to direction (nonisotropic). Generally, yield strength is higher in the rolling direction, whereas ductility is higher in the transverse direction. Other material properties can also be affected depending on the material and the amount of cold working. When manufacturers that use many rolling or forming operations understand how the material properties are evolving in each direction from one forming process to the next, they can texture the metal to improve suspension performance and reduce product rejection rates.

NASA Lewis' in-plane biaxial test systems were used to conduct a series of biaxial yield and failure surface probes on cold-rolled stainless steel sheet specimens. These test systems consist of a four-hydraulic actuator (500 kN) load frame, a state-of-the-art digital controller and innovative control software, an advanced quartz lamp radiant furnace (1500 °C), a large environmental chamber (10^{-6} torr capability), an acoustic emission sensing system, and an automated in situ crack-measurement system. The test system was modified to grip the thin-sheet specimens and provide a sensitive load range for these tests. Results indicated the orientations (with respect to rolling direction) where forming operations with cutouts or discontinuities would reduce stress concentrations. This information will help Hutchinson Technology reduce part rejection and improve suspension performance. In addition, a potentially damaging orientation was identified. In this direction, which should be avoided during any forming process, there is a significant strain localization that would result in a very high part rejection rate and a high probability of performance failure.

Options for Commercialization

The primary function of these test systems is to verify structural analysis methods under prototypical loading conditions. However, as in the test program just discussed, they can aid in the investigation and characterization of the multiaxial behavior of common materials. Furthermore, the facility allows the structural integrity of advanced monolithic and composite materials to be evaluated in subelement form. To bridge the gap between data from small coupon specimens to actual full-scale component response, we conduct tests on subscale structures that have relatively simple geometries (such as plates and beams). Unlike actual components, these subelement structures can be mechanically loaded and uniformly heated in a highly controlled and precise manner, making their analysis less complicated.

Because of proprietary issues, we cannot comment about the commercialization of the recording head suspension assemblies. However, in regards to the in-plane biaxial test facility, NASA Lewis is interested in any cooperative research project with industry, academia, or other government agency or department. Currently, work is being conducted with GE, Pratt & Whitney, and the Air Force. The Cleveland Clinic Foundation also has shown interest.

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Key Words

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Lewis Research Center